12
Supply: Costs of Production

The Product Supply Curve

The simple **product supply curve,** which should be a familiar image to you by now, moves upward to the right, representing a positive relationship between the price of a product and the quantity of output that producers wish to supply. In other words, as the price of a product increases, a greater quantity of that product is supplied, as shown in Figure 12-1.

But *why* do you think the supply curve has this particular shape? In our first encounter with supply-demand theory, we often hear a common-sense explanation of supply, such as: "When farmers see an increase in the price of corn, they will logically want to supply more corn to the market. If the corn price goes up (has a higher unit price), then more corn will be supplied to the marketplace."

Although this statement is probably true, it doesn't *prove* much. For us to really determine the fundamental nature of a supply curve, we must first understand how a producer maximizes profits. Decisions about profitability will, in turn, take us into the financial regions, where profits (revenue minus production costs) are determined. Let's begin our exploration of supply with

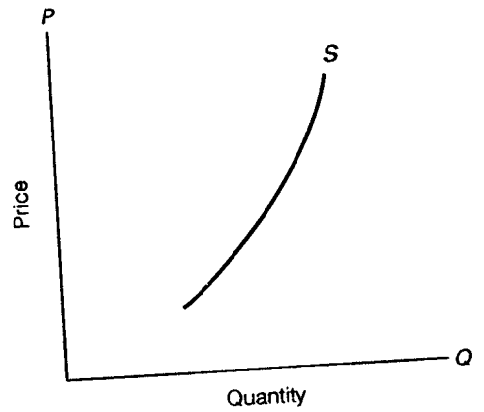

FIGURE 12-1 A simple *product supply curve* shows a positive relationship between price and quantity supplied. At higher prices, greater quantities are supplied; at lower prices, lesser quantities are supplied.

the subject of production costs, so that we can learn what really goes on "behind the scenes" of an average supplier.

Costs of Production

An interesting characteristic of product supply is that whenever we think we understand the fundamental concept, we suddenly discover, "Not quite!" We know that *production costs* play an important role in understanding profit maximization, but where do these costs come from? Think about it for a minute. You're probably saying, "Well, costs are determined by resource markets: the supply and demand for land, labor, and capital. From there, we get resource prices; from these prices, we derive costs." Supply and demand curves for the three major resources—land, labor, and capital—are shown in Figure 12-2. But now we are forced to ask, "What is the *origin* of the supply and demand for land, labor, and capital?"

Each question raises a new one as we travel backward into the heart of microeconomic theory. This process is reminiscent of Henry David Thoreau's attempt to find a "bedrock point of departure" from which he would begin his philosophical search for truth in *Walden* (1854):

> Let us settle ourselves, and work and wedge our feet downward through the mud and slush, . . . till we come to a hard bottom and rocks in place, which we can call reality . . . a place where you might find a wall or a state.

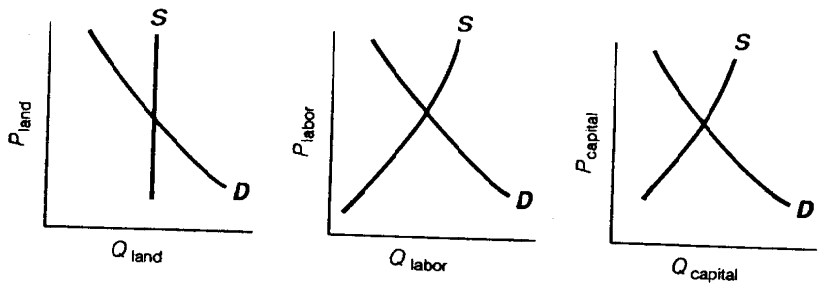

FIGURE 12-2 The supply and demand for resources determine the prices of land, labor, and capital. This information, in turn, becomes part of the supplier's production costs.

Can we find our bedrock concept—a solid principle of production from which we can build our "microeconomic wall"? The concept we are searching for is the well-known *law of diminishing returns*—one of the most important laws in all economics. Exactly how does this law relate to resource markets and production costs?

The Law of Diminishing Returns

Let's review the illustration of the law of diminishing returns in Chapter 4 (page 55) to see how it relates to production costs. We assumed that our hay-baling friend Chester Olson had a small farm of, say, 50 acres and a fixed amount of capital: one tractor, one baler, and one wagon. Recall that whenever we discuss diminishing returns, we *leave all resources fixed except one.*

Chester, working by himself, can bring in two loads of hay per day. When Jim joins Chester, Jim contributes an extra three loads of hay per day. Remember that the amount of hay that any one individual adds to the total is called his *marginal physical product* (MPP). So Chester's MPP = 2, and Jim's MPP = 3. Note that in this situation, the MPP is rising: Chester's operation is therefore experiencing *increasing returns.*

It is not difficult to see why Chester's hay-baling operation is in the stage of increasing returns. His fixed inputs (resources) are designed for two people. A simple two-person efficiency is achieved when one person bales hay while the other person stacks it on the wagon and when one person unloads the hay and the other person stacks it in the barn. But what happens when

Chester hires Steve, a third worker? What is Steve's MPP in relation to the other workers?

The addition of Steve to Chester's workforce increases the total daily output to six loads of hay. Therefore, only one unit (load) of extra output (MPP) can be attributed to Steve. With the addition of the third worker, the marginal physical product is beginning to fall (recall that Jim's MPP = 3). A declining MPP tells us that Chester's hay-baling operation has reached *the point of diminishing returns.*

Chester's total daily output is not lower because Steve is a less diligent worker but because the three-man crew is working with a limited amount of fixed inputs. One more tractor and wagon would make a major difference in Steve's productivity, but as a condition of our discussion of diminishing returns, we can't change any of the fixed resources.

Incidentally, diminishing returns would also occur if we held labor and land constant and added more capital. Diminishing returns is a universal law; it operates no matter what variable resource we are looking at.

You may enjoy, as I do, thinking through different kinds of production processes (like farming, teaching, raising children, operating a restaurant, studying for an exam, or operating a government department) and then trying to imagine at what stage the point of diminishing returns is likely to set in. For example, child-rearing (like hay-baling) is probably most efficient when it is conducted as a two-person operation. Or (to use perhaps a more relevant example for you) in cramming for an exam, you might observe, "I seem to have reached the point of diminishing returns," meaning that your most recent hour of study has produced a smaller amount of extra knowledge than the previous hour. You can see that the concept of diminishing returns can be applied to widely different situations!

Returning to Chester Olson's farm operation, can we now say that since Steve's low contribution is the result of the law of diminishing returns, Chester should not hire Steve? Recall that the answer to this question depends on the *monetary return* from Steve's contribution compared to the *wage* that Chester must pay him.

Steve's marginal physical product is only one load of hay. If that load of hay is worth $50, then the worth or value of Steve's MPP will be $50. We call this amount the **value of the**

marginal product of labor (VMP_L). The VMP_L of any worker can easily be found by multiplying the MPP by the price P of the final product:

$$VMP_L = MPP \times P$$

Once Chester figures out the VMP_L for *any* worker, all he has to do is compare this amount with the wage paid to that worker. Thus, the general rule for Chester to follow in hiring workers is to *keep hiring people as long as the VMP_L is greater than the wage W.*

This process is similar to the marginal decision-making process (discussed in Chapter 11) in which a consumer takes each dollar of income, one at a time, and asks where that dollar will give her or him the greatest utility. Now Chester also makes marginal decisions, but in this situation he asks, "Should I hire the first person? (Does Jim contribute to profits by bringing in a revenue that is larger than his cost?) Should I hire the second person? Should I hire a third?" And so on. Chester must make a separate marginal decision based on each person's monetary contribution to the business versus the wage Chester will have to pay that particular worker.

Should Chester have hired Jim? Jim's MPP = 3 loads. At \$50 per load, Jim's VMP_L would be \$150 per day. If we assume that Chester is paying the "going" wage of \$20 per day, then the worth of Jim's output is obviously far greater than the wage Chester pays him. Thus, in regard to Jim's contribution to business profits, Chester's marginal decision (and the answer to our question) is a resounding "yes."

Should Chester have hired a third worker, Steve (VMP_L = \$50)? At a wage of \$20 per day, Chester finds that it *is* still profitable to hire Steve, *despite diminishing returns,* because Steve's output earns Chester a \$30 marginal profit.

What about a fourth person? Let's say that a fourth worker, Joe, brings in one-half load per day. Even at such a low productivity rate, it is worthwhile for Chester to hire Joe because the value of his daily output (VMP_L = \$25) is still greater than his daily wage (\$20). Chester's marginal decision is now a more modest "yes" than before, but it is still a "yes." If the "going" wage were \$30 per day, however, there would be no economic advantage to hiring a fourth worker.

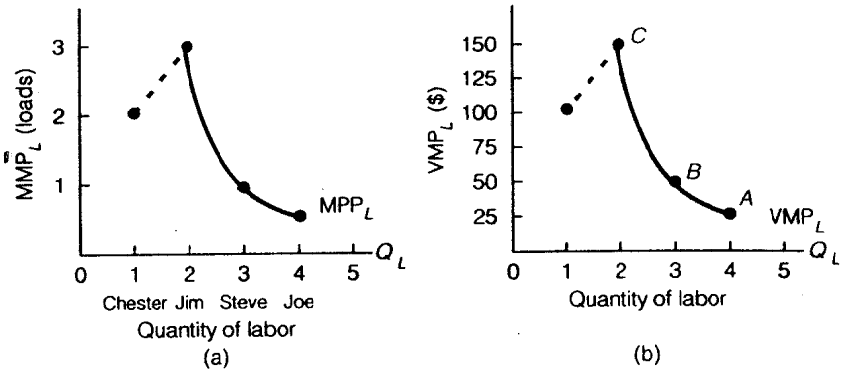

FIGURE 12-3 (a) A plot of the *marginal physical product* (MPP) for each worker (Chester, Jim, Steve, and Joe). (b) The *value of the marginal product of labor* (VMP_L) *curve* assigns a dollar value to each worker's contribution. These VMP_L values are based on the assumption that the hay that each worker produces can be sold for \$50 per load.

Thus, in regard to the profitability of hiring workers, Chester should clearly continue to hire up to the point at which the daily VMP_L equals the daily wage W. Even if a worker's VMP_L is \$20.01 and his wage is \$20.00, Chester will still earn a small profit (\$0.01) and should hire that worker. From now on, a general "rule of thumb," or profitability shortcut, will be to *continue to hire workers until the VMP_L of the last worker hired equals the wage W of that worker.* This shortcut, in turn, will offer us some insight into the nature of resource markets, including the demand for labor. Let's see how this works.

Demand Curve for Labor

The **demand curve for labor** is simply a series of points that tells us how many units of labor (the number of workers) will be purchased (by the producer) at different labor prices (wage rates). To see how the labor demand curve is related to the marginal physical product, let's graph Chester's MPP curve for labor (MMP_L) and the related VMP curve for labor (VMP_L) (see Figure 12-3), using the data we obtained earlier.

Based on the information given in the figure, we can easily work out labor demand. We can choose any wage; for example, let's choose \$25 per day. How many workers will Chester "demand"

if the daily wage for each worker is $25? The best way to answer this question is to go through the marginal decision-making process. Should Chester hire the first worker (himself)? Recall (page 182) that the answer will be "yes" as long as there is even a small amount of extra profit associated with that worker. The answer will also be "yes" for workers 2, 3, and 4. Our shortcut method gives us the same results: hire workers up to the point that $VMP_L = W$. In Figure 12-3(b), we see that a $25 wage is equal to a $25 VMP_L only when the fourth man is hired. Therefore, point *A* on Chester's labor demand curve is a $25 wage combined for four workers.

If, say, the wage rate is $50 instead of $25 per day, then Chester will hire up to and including the third man. (Remember that Steve's VMP_L = $50.) Thus, point *B* on Chester's labor demand curve is a $50 wage combined for three workers.

Finally, at a wage rate of $150, it is obviously worthwhile for Chester to hire only two people (himself and Jim), making *C* the third point on Chester's labor demand curve. This information is plotted in Figure 12-4(a). When the three points are connected, as they are in Figure 12-4(b), we have Chester's complete demand curve for labor.

It should be no surprise that Chester's labor demand curve looks precisely like the VMP_L curve in Figure 12-3(b). In fact, as long as Chester maximizes his profits so that $VMP_L = W$, then *the* VMP_L *curve becomes the labor demand curve!* The VMP_L curve is, in turn, a monetary representation of diminishing MPP_L.

Why does the labor demand curve slope downward? We now know that this downward slope reflects a declining MPP or, more simply, diminishing returns! This conclusion is true for any resource that we choose to be the short-run variable; the demand curves for capital and land are the same as their respective VMP curves. Thus, other resources also have downward-sloping demand curves that reflect their compliance with the law of diminishing returns.

We have derived the demand curve for a resource. To discover the origin of resource prices, so that we can understand the nature of costs, we must also develop a supply curve to complete our resource market. So let's take a look at the basic structure of a single supply curve, using labor once again as our variable resource.

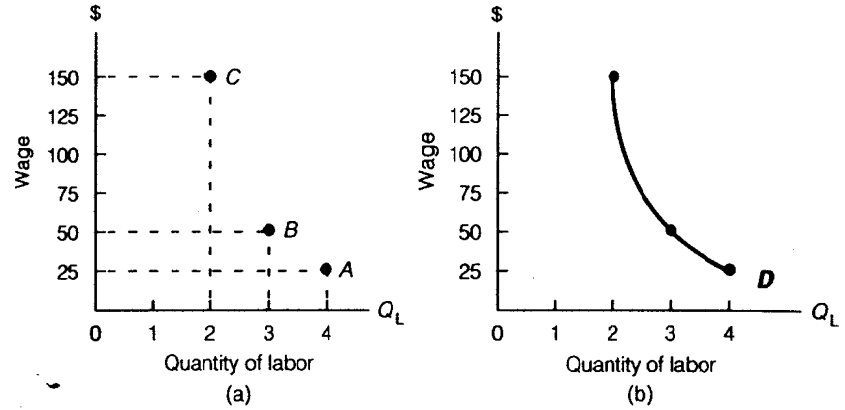

FIGURE 12-4 (a) Using marginal decision making to determine how many workers are hired at different wage rates, we are able to plot three labor-demand points. (b) These points are connected to form Chester's *demand curve for labor.*

Supply Curve for Labor

Labor supply is one of the more interesting topics in microeconomic theory, partly because it does not lend itself to a simple income-maximization process, as labor demand does. Instead, **labor supply** is influenced by psychological factors.

The subject of labor supply addresses different types of people and their unique preferences for work and leisure. How, for example, can we possibly use simple economic rules to explain why some people become "workaholics" and why other people seem to have nothing but free time to do whatever they want?

Obviously, all types of work attitudes must be taken into consideration when we discuss an individual's *willingness* to supply labor. Yet the general configuration of most people's **labor supply curves** would probably be somewhat similar. Let's see if we can construct this configuration.

Let's say you want to find out what Marsha's labor supply curve looks like. You will probably begin your investigation by asking her a question: "If you were given complete freedom to choose the amount of hours you wanted to work, how many hours would you choose to work per week if you received $2 per hour?" The answer will give you a single point on Marsha's labor supply curve. Next, you might ask, "How many hours a week

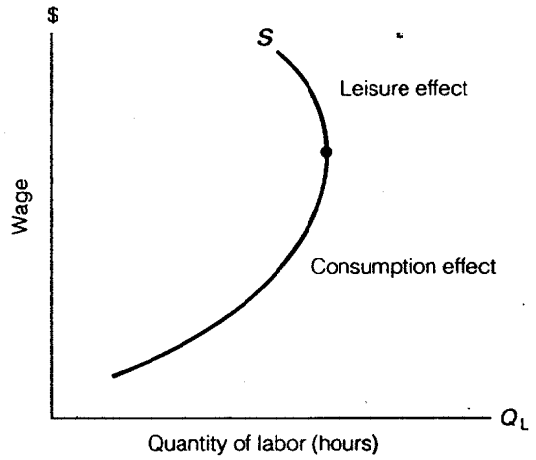

FIGURE 12-5 The *backward-bending labor supply curve.* As the wage rate increases, a person normally will want to work more hours; if this happens, then the *consumption effect* is dominant. If wage rates continue to increase, however, then a point will usually occur at which the worker voluntarily begins to cut the number of hours he or she works; if this happens, then the *leisure effect* is dominant.

would you work if wages were $3 per hour?" "If wages were $4 per hour?" And so on. You might also ask about Marsha's work preferences, even at very high wages. Each time she answers, you note the quantity of labor she is willing to supply under the stated conditions.

No doubt Marsha's response to a rising wage rate will probably be similar to most people's response. If the hourly wage is extremely low, she will probably be hesitant to "break her back" working a great many hours, unless she is forced to do so by necessity. As the hourly wage increases, the opportunity to earn greater income will probably be an incentive for Marsha to put in more hours. This direct, or positive, relationship (more hours worked at higher wage rates) we will call the ***consumption effect.*** It implies that a greater wage is a sufficient incentive to encourage Marsha to work longer to enlarge her income and to significantly improve her consumption level.

At some high wage level, however, a remarkable thing happens. Suddenly, "enough is enough"; any higher wage after this point results in fewer hours worked. Apparently, individuals want a greater amount of leisure time in which to enjoy a

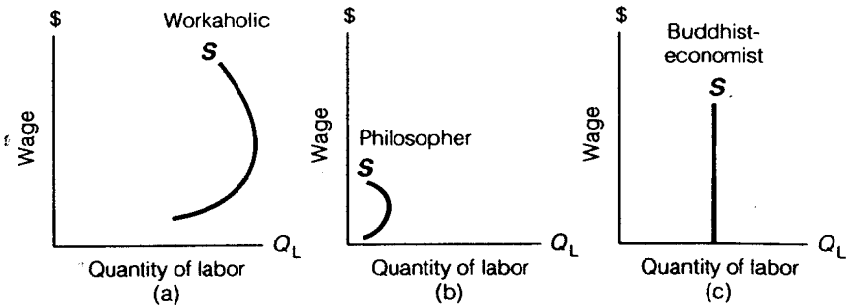

FIGURE 12-6 (a) The typical "workaholic" demonstrates a desire for large amounts of paid work. (b) The "philosopher" may move into a leisure pattern fairly quickly. (c) The "Buddhist-economist" may not be influenced by wage rates at all, whether they are low or high.

relatively higher income. When this happens, we might say that the ***leisure effect***[38] has become more powerful than the consumption effect.

The leisure and consumption effects are graphed in Figure 12-5. Due to the consumption effect, the labor supply curve has a positive slope until a certain point; then it begins to turn backward and have a negative slope when the leisure effect takes over. Economists refer to this curve as the **backward-bending labor supply curve.**

It is sometimes interesting to experiment with different curve shapes, each of which demonstrates a variety of work attitudes and work-behavior patterns. Just for fun, let's try three radically different work models: the workaholic, the philosopher, and the Buddhist-economist.

The workaholic's labor supply curve will probably show high initial work loads that increase even more as the wage rate increases. Workaholics seem to need lots of work, and the opportunity to achieve higher and higher consumption levels prods them on as the wage rate increases. For such people, the leisure effect is evident only after extremely large quantities of labor have been supplied, as shown in Figure 12-6(a).

Next, we will look at the other end of the work spectrum, at the philosopher. In *Walden*, Thoreau advocates a simple, low-overhead lifestyle, saying his greatest skill "has been to want but little." This philosophy led Thoreau to something that was not quite voluntary poverty but was close to it:

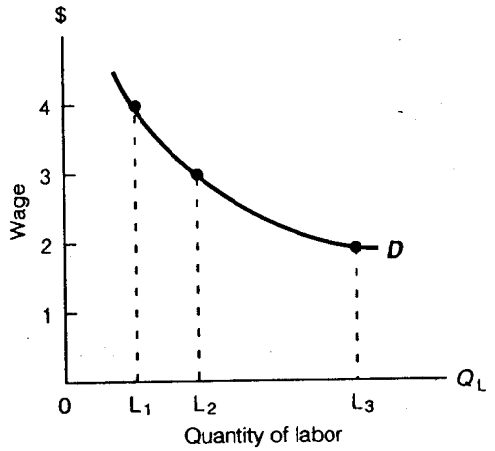

FIGURE 12-7 The *industry labor demand curve* is the summation of all workers hired by all employers in the industry at various wage rates.

> I found that by working about six weeks in a year, I could meet all the expenses of living. The whole of my winters, as well as most of my summers, I had free and clear for study.

What would Thoreau's labor supply curve look like? Apparently, it would bend back very quickly, like the one in Figure 12-6(b).

A final labor-supply model is the Buddhist-economist model, based on E. F. Schumacher's description (page 152) of an individual who is motivated not necessarily to earn wages but to develop personal character and lead a "dignified existence." Too much or too little work would not be an ideal situation for the Buddhist-economist. Thus, the supply curve would not have an upward slope or a backward-bending section; it would rise in a straight vertical line at the "ideal" level of labor, as shown in Figure 12-6(c).

You might want to draw an approximation of your own labor supply curve. Which one of the three models in Figure 12-6 does your curve resemble the most?

A Labor Market

So far, we have examined a single producer's demand curve for labor and a single person's labor supply curve. What we need to find out now is what the *overall* industry supply and demand

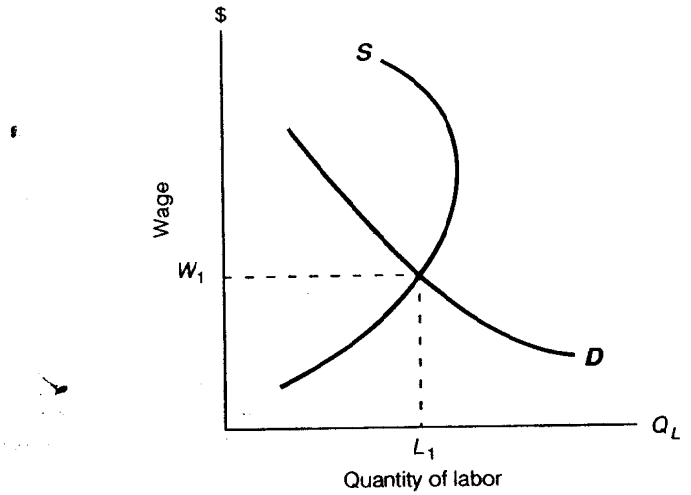

FIGURE 12-8 A typical labor market sums up the total quantity of labor demanded and the total quantity of labor supplied in a particular industry. The *equilibrium price* (wage W_1) is important information in determining production costs.

curves look like. This is not too difficult to do. To determine the industry demand for hay, for example, all we need to do is ask *all* the hay farmers the same question we already asked Chester Olson: "How much labor would you demand at different wage rates?"

Suppose that at a $4 hourly rate, Chester maximizes his profits with x workers; Jones, with y workers; Smith, with z workers, and so on. Then we simply add up the total numbers of workers $(x + y + z)$ at that particular wage rate. This information gives us the first point on the demand curve (see point L_1 in Figure 12-7). We go through the same addition process to obtain point L_2 at a $3 wage rate and point L_3 at a $2 wage rate. Connecting these three points gives us the **industry labor demand curve** in Figure 12-7.

The **industry labor supply curve** is determined in a similar way. We add up the total amounts of labor that all workers in that particular market are willing to put forth at different wage rates.

In Figure 12-8, the industry labor supply curve is combined with the industry labor demand curve. Together, they form our theoretical **labor market**—a unique supply-demand situation

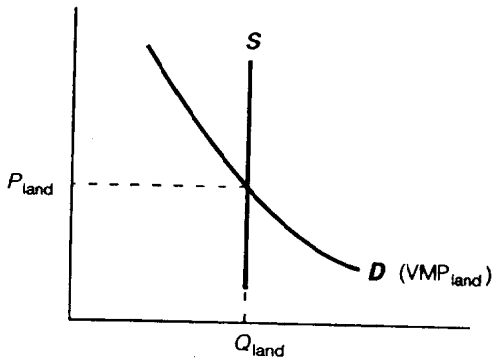

FIGURE 12-9 The *supply of, and demand for, land:* note the fixed (vertical) supply of land, implying that a land resource does not respond to changes in land price. Both land price and quantity will be used to calculate production costs.

that generates an *equilibrium price* (wage W_1) and an *equilibrium quantity of labor* (L_1).

We have derived demand and supply curves for the labor market, but what about the other two resource markets for land and capital? We had a brief look at these markets in Figure 12-2. How do we determine the prices of these resources?

We can apply a similar analysis to both land and capital. The **demand curve for land** is land's VMP curve. It slopes downward due to diminishing returns, just as the labor demand curve does.

The other half of the land market is the **supply curve for land**. We know, by definition, that the supply of land is fixed; there are only so many land resources, no matter how much the price of land varies. Thus, supply curve for land is simply a vertical line at the fixed quantity of land resources. The combined supply-demand market for land, with an equilibrium price (P_{land}), would look something like the graph in Figure 12-9.

The **demand curve for capital** is the its $VMP_{capital}$ curve; the **supply curve for capital** is determined by the available capital stock at any one time. The equilibrium price $P_{capital}$ is often expressed as a rate of interest. Thus, a short-run market for capital would be similar to the graph in Figure 12-10.

We have now reached the conclusion of this chapter on production costs. We have traced short-run production theory from the law of diminishing returns through simple resource

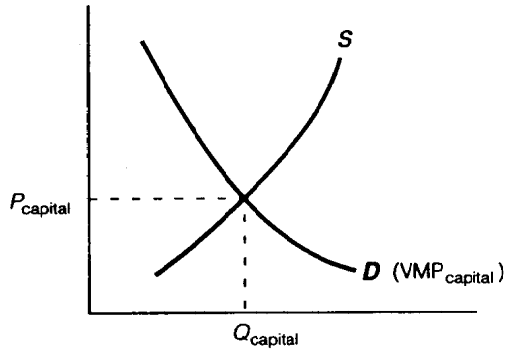

FIGURE 12-10 A *short-run market for capital:* the supply curve intersects the demand curve at an equilibrium price and quantity, supplying capital-cost information to businesses.

markets and, from this, have learned how resources are priced. From these prices, we can calculate a producer's costs of production!

In Chapter 13, we will combine these production costs with the concept of producer revenues. This knowledge will, in turn, lead us to the product supply curve.